ISSN: 2278-2648

International Journal of Research in Pharmacology & Pharmacotherapeutics (IJRPP)

IJRPP |Vol.13 | Issue 4 | Oct - Dec -2024

www.ijrpp.com

DOI : https://doi.org/10.61096/ijrpp.v13.iss4.2024.420-426

Review

Review of *Petrocarbus Santalinius Linn.*

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Published on: 20 Oct 2024

Published by:
DrSriram Publications

Abstract

Several traditions make use of the Red Sandalwood tree, *Pterocarpus santalinus Linn*, which grows along the coast of India. *Pterocarpus santalinus Linn.* Contains a variety of phytochemical components, including isoflavone, glucosides, alkaloids, phenols, saponins, glycosides, flavonoids, triterpenoids, sterols, and tannins. The plant *Pterocarpus santalinus Linn* has a variety of pharmacological properties, such as antitubercular, cytotoxic, antioxidant, antibacterial, and anti-inflammatory qualities. It also has antipyretic, anthelmintic, tonic, hemorrhage, dysentery, aphrodisiac, and diaphoretic activities, as well as antiviral, anti-oxidase, and anti-tyrosinase inhibitory, antioxidant, wound healing, and anti-ulcer properties. Future researchers will find this review report helpful in monitoring this multipotent tree for possible medical research that could contribute to maintaining the equilibrium of life. However, despite numerous claims of pharmacological activity, the species has not been thoroughly investigated. Thus, *Pterocarpus santalinus Linn,* Phytochemical and pharmacological properties were reviewed in this paper.

Keywords: *Pterocarpus santalinus Linn*, medicinal plants, antiviral, anti-inflammatory, and anti-diabetic properties.

INTRODUCTION

P. santalinus is an evergreen tree in the Fabaceae family that grows to a small to medium size. Tropical parts of the world, including China, Taiwan, India, and Sri Lanka, are home to a large population of it. Natural plant products are an excellent source of bioactive chemicals and have been utilized throughout for medical purposes. The development of novel medications for the treatment of many ailments, such as diabetes and cancer, has led to an increase in scientific interest to eastern medicine recently. The World Health Organization (WHO) supports research into the potential advantages of plants as potent medicinal agents, particularly in regions where there is a dearth of contemporary, safe medications. Phytoextracts derivatives account for one-third (35%) of all pharmaceutical used in the United States and 80% of medications used in rapidly developing countries like China and India. India possesses an abundance of diverse medicinal plants that are utilized for treating various ailments

by both traditional healers and the local populace. Pterocarpus santalinus is one such plant, and because of its many medicinal applications, it is used to treat a wide range of illnesses. [1]

Herbal medicine has been used for healing for as long as people have existed. There is substantial evidence from a variety of sources, including written documents, preserved monuments, and even original plant medicines, demonstrating the long-standing connection between man and his hunt for pharmaceuticals in nature. Many years of fighting diseases have taught us to seek out pharmaceuticals in the barks, seeds, fruit bodies, and other parts of plants. As a result, we are aware of the use of medicinal plants. [2].

Medications are officially recognized as part of India's ancient medical system and have a wealth of historical history. The system explains the medicinal plant, plant part, preparation method, and use for curing, treating, or lessening particular ailments, either by itself or in conjunction with other plants. [3].

Pterocarpus santalinus L.f., commonly known as Red sanders (English), Raktachandan (Sanskrit) and Kempu honne (Kannada). It is an endangered and endemic to Andhra Pradesh. [4]

P. Santalinus- Tree

P. Santalinus- leaf, seed, flower

P. Santalinus- Resin

P. Santalinus- bark

Fig 1: Pterocarpus Santalinus L.f.,

Pterocarpus santalinus L., sometimes referred to as Red Sanders, Red Sandalwood, or Rakthachandan, is a member of the Fabaceae family. Located on arid, mountainous, and frequently rocky soils in the Deccan Peninsula of India, Red Sanders is a useful medicinal angiospermic tree. It is found in the Eastern Ghats region of Andhra Pradesh as well as in the nearby regions of Karnataka and Tamilnadu. This species is in danger of extinction. The tree is well-known for its unusual, breathtakingly beautiful, and vibrant wood, which is used as a coloring agent in pharmaceutical materials and is also assessed for its potential therapeutic benefits and used in drug formulations. The wood is also used to treat a variety of conditions, including diabetes, skin conditions, inflammations, headaches, blood disorders, stomach ulcers, anthelmintic, and dysentery. [5]

Phytochemical constituent

Table 1: Methanol and ethanol extracts yield of bark and heartwood of *P. santalinus.*

S.No.	Plant sample	Plant extract yield (%)			
		Bark		Heartwood	
		Ethanol	Methanol	Ethanol	Methanol
	Pterocarpus santalinus	8.41 ± 0.002	11.71 ± 0.002	8.21 ± 0.01	11.42 ± 0.02

Note: % - Percentage

Table 2: Phytochemical Screening of methanol and ethanol extracts of *P. santalinus bark* and heart wood.

S. No.	Phytochemicals	Bark		Heartwood	
		Ethanol extract	Methanol extract	Ethanol extract	Methanol extract
1.	Alkaloids	+	+	+	+
2.	Flavonoids	+	-	+	-
3.	Tannins	+	+	+	+
4.	Saponins	-	+	-	+
5.	Steroids	-	-	-	-
6.	Phenol	+	+	+	+
7.	Glycosides	-	-	-	-
8.	Protein	-	-	-	-
9.	Carbohydrates	-	-	-	-
10.	Terpenoids	+	+	+	+

Note: "+" - Present; "-" – Absent

A phytochemical examination of Pterocarpus santalinus Linn. demonstrated the presence of a variety of substances, including glycerides, glycosides, anthocyanins, saponins, tannins, phenols, triterpenoids, flavonoids, and carbohydrates. The following phytoconstituents were present in P. santalinus methanol and ethanol extracts, A phytochemical examination of Pterocarpus santalinus Linn. demonstrated the presence of a variety of substances, including glycerides, glycosides, anthocyanins, saponins, tannins, phenols, triterpenoids, flavonoids, and carbohydrates. [6]

Sesquiterpenes

A bis hydroxyl methyl analog with an aromatic ring is 12, 15-dihydroxycurcumene (1)*, whereas hamahasal A (2) * has both hydroxyl and aldehyde groups. [7] Reports of (S) - (+)-curcuphenol from Didiscus oxeata, a marine Jamaican sponge. [8], Eth-4(15)-eudesmen-1 α, Canusesnol K (3)*, Canusesnol L (4)*, Isopterocarpolone (5)*, 11-diol (6)*, Pterocarpol (7)*, (3β)-eudesm-4(14)-ene-3, 11-diol (8)*. [9], [5, 6, 7], [^{2}-eudesmol (11)*, [pterocarptriol (9)*), [pterocarpdiolone (10)*, and [cryptomeridiol (12)*]. [10]

Triterpene and steroids

Lupeol (13), epi-lupeol (14)*, betulin (15)*, lup-20(29)-en-2, 3β-diol (16)*, lup-20(29)-en-2 α, 3α-diol (17) *, and lupenone (18)*, β-amyrin (19)*, β-amyrone (20)*, erythrodiol (21)*, acetyl oleanolic acid (23)*. According to Krishnaveni and Rao (2000a), [11] Ketoo leanane (24)*, an oleanane triterpenoid, is found from the callus culture. The two most prevalent phytosterols, β-sitosterol (26)* and stigmasterol (25)*, β-sitosterol (26)*, and stigmasterol (25)*. [13].

Flavonoids

Taxifolin (27)*, epicatechin (32)*. [14], Dihydrokaempferol (28)*, Naringenin (29)*, and Eryodictyol (30)*. [15], liquiritigenin (31)*. [16], (-)-fisetinidol (33)*, Flavonoid quercetin (34)*, glycoside rutin (35)*. [17], Isoflavone (36)*, Neoflavonoids (37)*, pyran (38)*. [18]

Benzofurans

Benzofurans (39)*, benzoquinone (40) *. [19]

Coumarins

5-hydroxy-7-O-(3-methyl)-but-2-enyl coumarin (41)*. [20], 6-hydroxy-7-methoxy coumarin (42)*, 7-hydroxy-6-methoxycoumar in-7-O-[β-D-apiofuranosyl (1→6)-β-D-glucopyranoside (43)*, and 7-hydroxy-6-methoxycoumarin-7-O-[α-L-arabinopyranosyl(1→3)-β-D-galactopyranosyl(1→6)-β-D-galactopyranoside (44)* .[21] , 1,3 benzodioxol moieties, savinin (45)*, and calocedrin (46)*, pterocarpin (47)*, and homopterocarpin (48)*.[22]

Aurone and chalcone

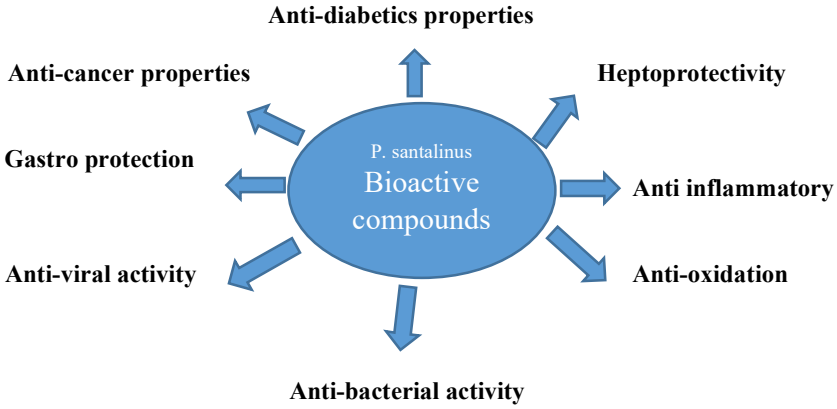
6-hydroxy 5-methyl 3 ′ aurone 4-O α-L-rhamnopyranoside (49)*, 6, 4 ′, 4 ′, 5 ′ trimethoxy -dihydroxy aurone 4-O- rutinoside (50)*. [23], pterolinus L (51)*. [18], isoliquiritigenin (52)*,[16].

Miscellaneous

Pterolinus K (53)* [18], stilbenes, pterostilbene (54)* [12], and cis-piceid (55)*; phenolic acids, protocatechuic acid (56)* [24], and gallic acid (57)* [17]. Coumarin (58)*, p-coumaric acid (59)*, ferulic acid (60)*, syringic acid (61)*, vanillic acid (62)* and α, β-resorcylic acid (63*, [25].

Pharmacological activities

There has been an increasing interest in natural products based drug discovery and healthcare products based on traditional knowledge and folk medicines. P. santalinus is also explored for its potential to combat illnesses based on profound traditional claims. These claims and reported pharmacological activities are,



Anti-inflammatory activity

The extract may be able to stop mast cell degranulation, inflammatory eosinophil infiltration, hyperkeratosis, itching, and epidermal thickening. The bark extract also inhibits the mRNA expression of proinflammatory cytokines (in dorsal skin lesions), chemokines (Th1 and Th2 immune responses), and cytokines. [14]

Anti-oxidant activity

P. santalinus has long been utilized to treat oxidative stress-related diseases because it is known to contain polyphenolic substances. An analysis revealed that the chloroform fraction of heartwood crude extract, which was produced by macerating the extract with 90% ethanol, has Radioprotective and antioxidant properties. It was discovered that the fraction included 12.447 g/L total tannins, 0.066 mg cyn3-glu/g, 22.6 µg/mL total flavonoids (quercetin equivalent), and 404 µg/mg total phenols (gallic acid equivalent). The fraction showed encouraging potential for radioprotection and antioxidants when tested in various settings, including mouse splenic lymphocytes. [22]

Anti-cancer activity

The IC50 for the heartwood extract was 17.10 µg/mL. Overall, neoflavonoids outperformed benzofurans in terms of cytotoxicity. The activity of the benzofurans was decreased by further changing the B ring substitution pattern, substituting at C-3 instead of C-2, and saturation at the C2-C3 position. Additionally, compounds with an open C ring showed a lot of activity. According to this study, the activity depends on orientation, substitution pattern on the B ring, and substitution position at the C ring. Doxorubicin was employed as a reference standard; however, the lack of IC50 values makes it difficult to draw conclusions from the study. Additionally, melanoxoin was not the subject of an in-vivo investigation or a mechanistic exploration, despite being one of the main compounds and a strong one, as the paper indicates. Given that the primary compound exhibited strong inhibition, it provides scope for further development as an anti-cancer lead with detailed mechanistic studies and in-vivo validation. [18]

Anti-viral activity

The lead-like improved extraction process was used to prepare the wood extract, which was then tested against the influenza virus A/Hong Kong/68 (HK/68) with a selectivity index of 4.6 (CC 50 /IC 50) and an IC 50 of 12 µ g/mL. It was unable to demonstrate any inhibitory effect against rhinovirus A2 (RV-A2) and coxsackievirus B3 (CV-B3). [27]

Anti-bacterial activity

Along with clinical isolates of H. pylori, the ethanolic extract of heartwood showed anti-H. Pylori action (IC 50 20 µ g/mL) in rat stomach epithelial cell cultures. The test system treated with extract showed normal appearance of the epithelial cells and decreased levels of urease activity, lipid peroxidation, and lactate dehydrogenase. [28]

Tyrosinase inhibitory activity

Reduced melanin synthesis resulted from Santalinus dose-dependent inhibition of Tyrosinase, which was of a mixed type. Its interaction with the fluorophore amino acid residue changed the secondary helical shape, according to the mechanistic analysis. Santalin was found to downregulate Tyrosinase, MITF, TRP-1, and 2 in B16F0 melanoma cells without causing any cytotoxicity, according to cell line experiments. [29]

Monoamine oxidase inhibitory activity

In a high throughput screening research, *P. santalinus* showed inhibitory activity against the human monoamine oxidase enzyme. Its inhibitory concentration (IC 50) ranged from >0.2 < 0.4 mg/mL, indicating promise for use in the treatment of Parkinson's disease. It is important to note that the study was conducted using an extract, and that it requires confirmation using a variety of in-vitro and in-vivo models by identifying the chemicals involved and revealing underlying mechanisms. [30]

Anti-diabetic activity

In the alloxan-induced diabetic Wistar albino rats, three different extracts (0.25, 0.5, 0.75, and 1 gm/kg) made from the bark with hexane, ethanol, and water at room temperature were assessed for their anti-hyperglycemic potential. The ethanolic extract at 0.25 gm/kg produced maximum anti-hyperglycemic activity and reduced blood glucose by 58.5%, which is higher than glibenclamide (26.2%). Normal animals did not exhibit any hypoglycemic effects from these substances. [31]

Wound healing activity

The innermost 40–50 m of the stem pulverized in 15% w/w petroleum jelly was used to create a formulation that was tested on male Charles Foster rats with punch, burn, and diabetic wound models. In comparison to the vehicle, untreated, and human placental extract groups (12 days), the petroleum jelly formulation demonstrated a contraction of 2.45 ± 0.08 mm 2 ($p < 0.05$) in 9 days for the punch wound. (Table 1). The scientists concluded from their overall data that P. santalinus supports karyogenesis and cytogenesis, which have been linked to the previously known chemicals tri terpenes, isoflavones, and santalin A and B. However, the activity of specific compounds has not been determined. [32]

Anti-ulcer activity

In accordance with conventional wisdom, the heartwood ethanolic extract, when tested against ibuprofen-induced stomach ulcers in male Wistar Albino rats, demonstrated a significant reduction in gastric lesions at the lowest effective dose of 200 mg/kg body weight. Furthermore, because the extract has the ability to block acid production, operate as an antioxidant, and preserve the integrity of the cell membrane, it was found to have numerous ways of contracting ulcers. In this instance, specific anti-ulcer activity has been documented for heartwood extracts, citing the existence of lignans and triterpene with anti-oxidant and anti-ulcer qualities from external sources. [33]

CONCLUSION

The native *P. santalinus* population is under a great deal of stress due to the rising demand. P. santalinus bark and heartwood are good natural sources of antioxidants for industrial and medicinal applications because they include flavonoids, terpenoids, phenols, and polyphenolic compounds. Nonetheless, the possibility that this plant contains special compounds with a range of pharmacological properties is likely what has led to a current increase in study interest. Therefore, more research on phytochemicals will be required to determine the pharmacological effects of this type of plant.

CONFLICT OF INTEREST

The author has no conflict of interest.

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